CERES industrial consortium sponsored project:

PhD2 – Lubricants for oil-injected positive displacement machines

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Background: Oil injected positive displacement machines include screw, scroll, vane and other types of compressors and expanders. These are used in refrigeration, air conditioning, Organic Rankine Cycles with refrigerants or hydrocarbons, in air compression and in gas compression for oil and gas and process industries etc. Oil is injected in the working space of this machine to remove heat from compression process, seal leakage gaps and lubricate rotors, bearings and seals. By this means, higher compression ratios may be achieved within single compressor stage, and temperatures within the machine are controlled so that the gas at the discharge usually does not need to be additionally cooled. Therefore, oil injected positive displacement machines are smaller, simpler and cheaper than their oil free equivalents and not surprisingly, around 90% of all positive displacement machines in use are oil injected. However, they require separation of the injected liquid, and the delivered gas will always contain some small amount of oil which in some cases may be undesirable.

Extensive efforts, both from academia and industry, have been reported to identify requirements and develop oils for oil injected positive displacement machines and today variety of oils are available for different applications, both mineral and synthetic. With ever more demanding requirements on positive displacement compressor and expander industry to become carbon neutral, importance of lubricants used in these machines becomes imperative. Ideally, production of lubricants should be carbon neutral, and these should enhance heat exchange, reduce leakages and improve lubrication so that the amount of lubricant in the machine is reduced and that it does not affect environment and the main gas or vapour compressed or expanded. In addition, suitable lubricants do not exist for some applications such as, for example, water vapour compression and expansion. It was identified form the available literature that there is gap in detailed understanding of requirements for lubricants in respect to making them and machines where these are used carbon neutral.

Objective: The aim of the of the proposed research project is to set criteria for defining new carbon neutral lubricants for positive displacement machines and develop requirements and tools for selecting lubricants for new generation of environmentally friendly positive displacement machines.

The objectives are:

- Review state-of-the-art literature on lubrication and lubricants in positive displacement machines and specify critical parameters which should be investigated for carbon neutral lubricants for PDM's
- Develop analytical and numerical tools to evaluate manufacturability and application of novel lubricants for manufacturers and users of these lubricants for carbon neutral oil injected positive displacement machines.
- Validate the developed tools by extensive experimental investigation on a typical oil injected air screw compressor.

Outcomes: The project will deliver the following outputs:

- Comprehensive review of lubricants for PDM's and their environmental impact.
- Analytical and/or numerical tool for selection and evaluation of lubricants for future positive displacement machines in carbon neutral energy systems.
- Guidelines for using novel lubricants in PDMs for carbon neutral energy systems.
- Experimental validation of tools for selection of carbon neutral lubricants for novel screw machines.

The project will fully fund 3 years of a PhD student including a scholarship and bursary in the amount of £17,500 p.a.

It is expected that the candidate has a good mathematical background, excellent knowledge of thermodynamics and fluid mechanics and holds a Master's degree in mechanical engineering or related discipline. Good skills in using programming languages such as Python or similar are desired. The candidate is expected to have a positive attitude toward teamwork, ability to work proactively and independently and has motivation to learn and contribute to this multidisciplinary project.

References

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